



Computer Networks

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Course Details



- Course Title
 - Computer Networks
- Credits
 - 03
- Instructor
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Textbook and Reference Materials

- Data and Computer Communications by William Stallings
- Computer Networking: A top down approach by Kurose And Ross

Deliverables



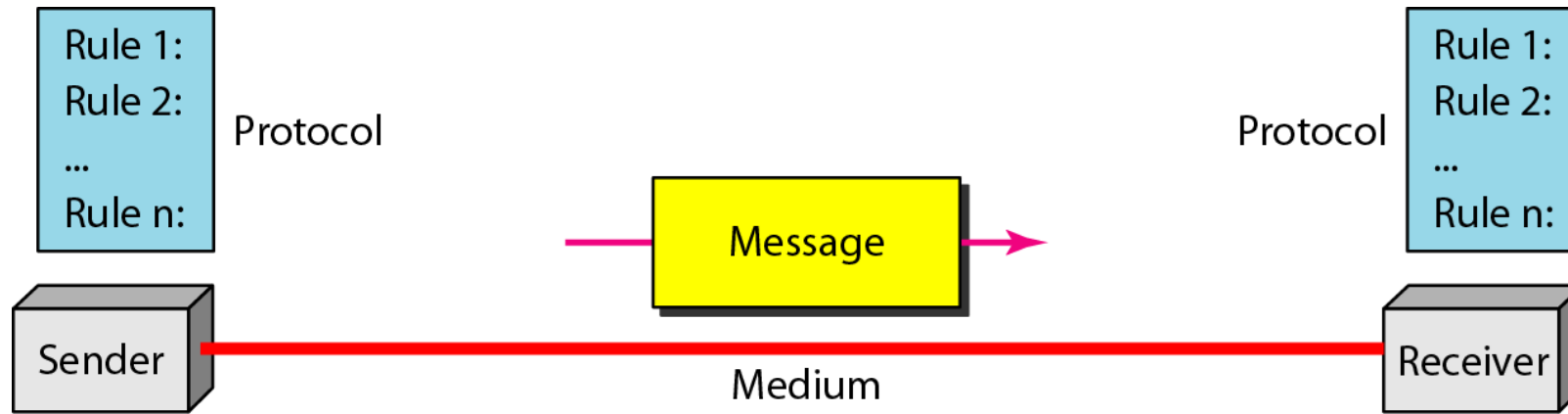
- Sessional Exams
- Assignments (optional)
- Quizzes
- Final Term Exam

Introduction



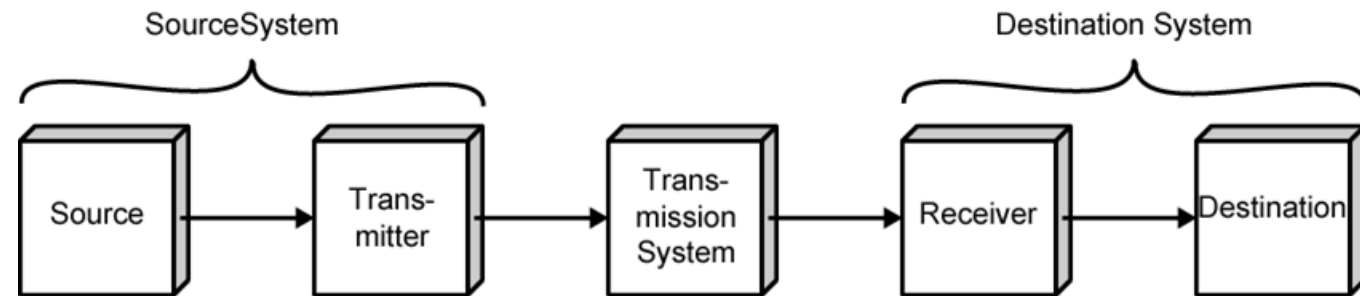
- **Data communications** deals with the **transmission of signals over a distance** in a **reliable** and **efficient** manner.
- The fundamental problem of communication is that of **reproducing** at the receiving point **either exactly or approximately** a message transmitted from the sending point

Five components of data communication



A Simple Communications Model

- Source
 - generates data to be transmitted
- Transmitter
 - Converts data into transmittable signals
- Transmission System
 - Carries data
- Receiver
 - Converts received signal into data
- Destination
 - Takes incoming data



Communications Tasks



- This simple model conceals a wealth of technical complexity. To get some idea of the scope of this complexity, let's see the key tasks that must be performed in a data communications system

Transmission system utilization	Addressing
Interfacing	Routing
Signal generation	Recovery
Synchronization	Message formatting
Exchange management	Security
Error detection and correction	Network management
Flow control	

Communications Tasks



- **Transmission system utilization**
 - Need to make efficient use of transmission facilities typically shared among a number of communicating devices
- **Interfacing**
 - a device must interface with the transmission system
- **Signal Generation**
 - once an interface is established, signal generation is required for communication

Communications Tasks



- **Synchronization**
 - there must be synchronization between transmitter and receiver, to determine when a signal begins to arrive and when it ends
- **Exchange Management**
 - there is a variety of requirements for communication between two parties that might be collected under the term exchange management
- **Error detection and correction** are required in circumstances where errors cannot be tolerated

Communications Tasks



- **Flow control** is required to assure that the source does not overwhelm the destination by sending data faster than they can be processed and absorbed
- **Addressing and routing**, so a source system can indicate the identity of the intended destination, and can choose a specific route through this network
- **Recovery** allows an interrupted transaction to resume activity at the point of interruption or to condition prior to the beginning of the exchange

Communications Tasks



- **Message formatting** has to do with an agreement between two parties as to the form of the data to be exchanged or transmitted
- **Security**: Frequently need to provide some measure of security in a data communications system
- **Network management** capabilities are needed to configure the system, monitor its status, react to failures and overloads, and plan intelligently for future growth

Transmission Medium

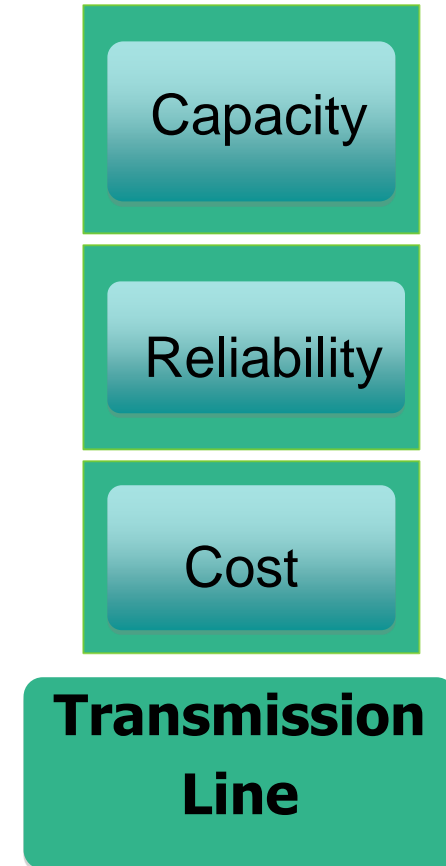


- One of the **basic building blocks** of any communications model is the **transmission line**.
- Despite the growth in the capacity and the drop in the cost of transmission facilities, transmission services remain the most costly component of communications.
- Thus, we need to be aware of techniques that increase the efficiency of the use of these facilities, such as multiplexing and compression.

Transmission Medium



- Three important factor of a transmission medium are
- Capacity,
- with acceptable reliability,
- at minimum cost.



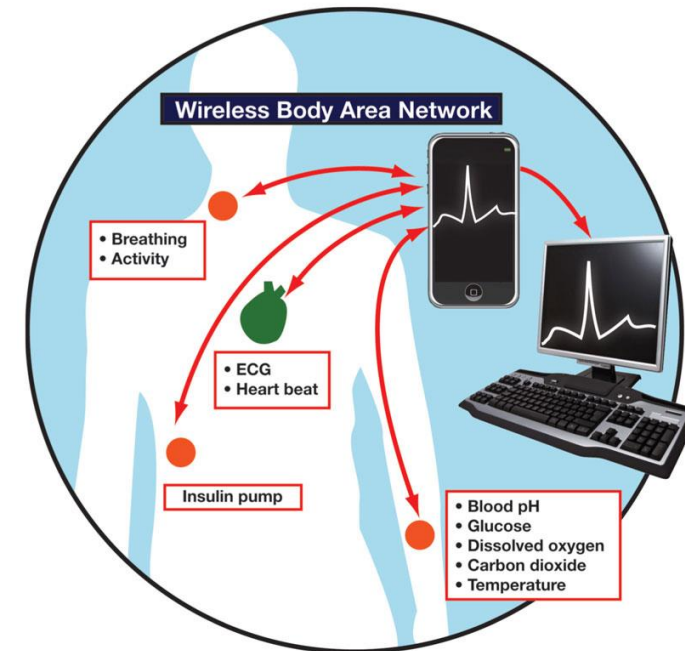
Networks

- Growth of number & power of computers is driving need for interconnection
- A set of computers, servers or other communicable devices connected together (through wire or wirelessly), to share information is called a network.



BAN

- A body area network (BAN), also referred to as a body sensor network (BSN), is a wireless network of wearable computing devices.
- Restricted to your body
- Range about 1 meter
- Bluetooth, infrared
- Data rate Less than 1mbps



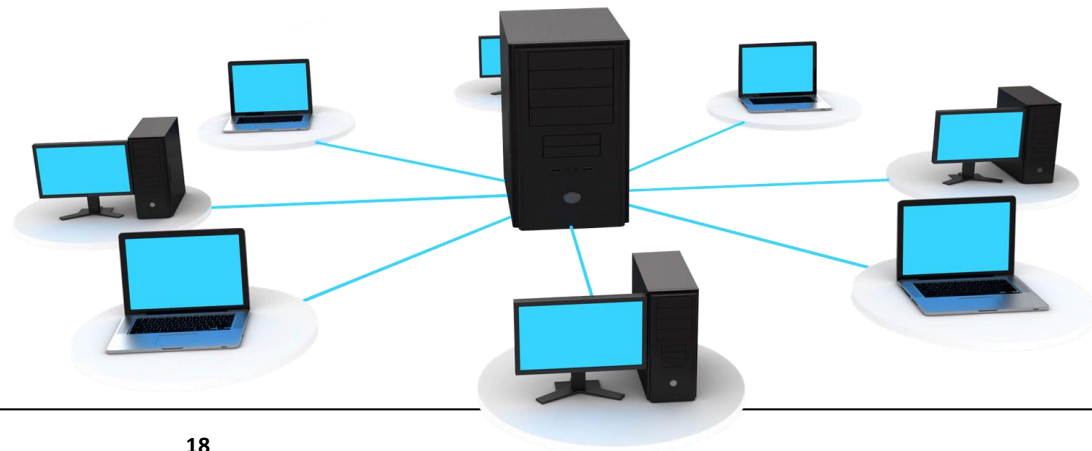
PAN

- A personal area network (PAN) is a computer network used for data transmission amongst devices such as computers, telephones, tablets and personal digital assistants.
- Restricted to personal area
 - Office desk, bed, room etc
- Range about 5 meter
- Bluetooth, NFC, infrared
- Data rate Less than 2 mbps



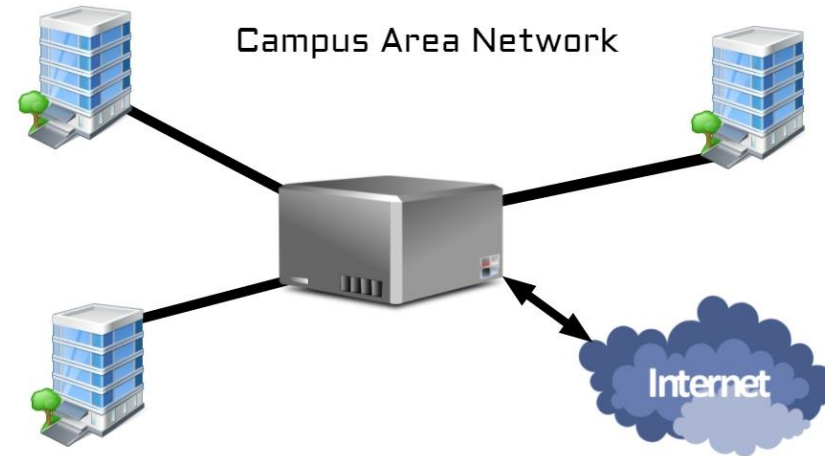
LAN

- A local area network (LAN) is a computer network that interconnects computers within a limited area such as a residence, school, laboratory or office building.
- Restricted to a building, residence etc
- Range 5m to 1 km
- Cables, Wifi, cellular
- Data rate 2 + mbps



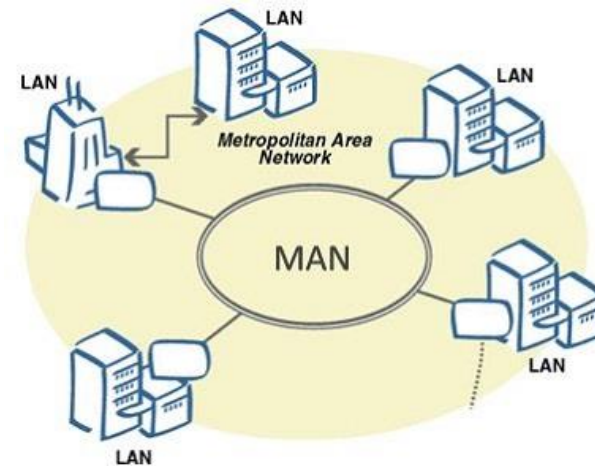
CAN

- A Campus Area Network (CAN) is a computer network that links the buildings and consists of two or more local area networks (LANs) within the limited geographical area. It can be the college campus, enterprise campus, military base, industrial complex.
- Restricted to a campus
- similar to LAN
- Range 5m to 1 km
- Cables, Wifi, cellular
- Data rate 2 + mbps



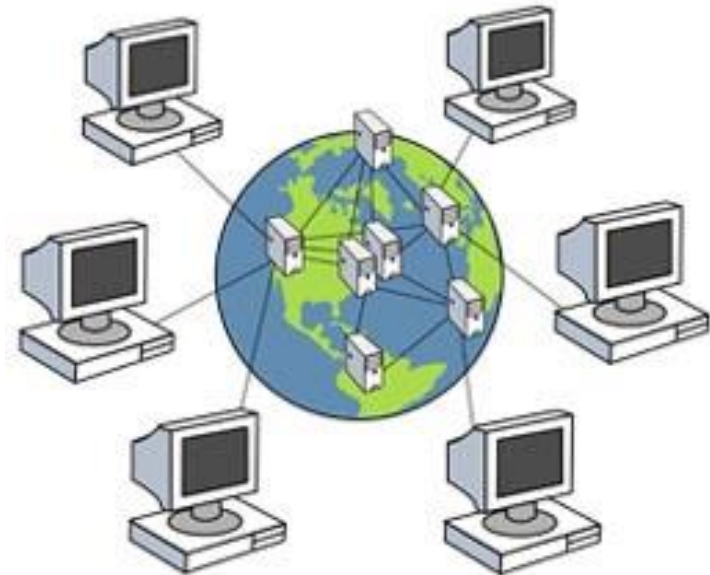
MAN

- A metropolitan area network (MAN) is a computer network that interconnects users with computer resources in a geographic area or region such as which spans an entire city
- Restricted to a city or large area
- Range 1km to 50 km
- Cables, Wifi, cellular, 3G, 4G
- Data rate 2 + mbps



WAN

- A wide area network (WAN) is a telecommunications network or computer network that extends over a large geographical distance such as a state, province or country.
- large geographical area
- Range 50km to 1000 km
- Cables, cellular, satellite, 3G, 4G
- Data rate 2 + mbps



The Internet

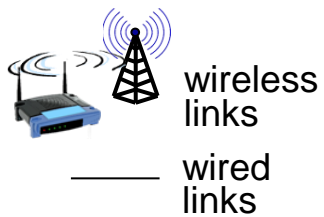


- The Internet evolved from the ARPANET, developed in 1969 by the Advanced Research Projects Agency (ARPA) of the U.S. Department of Defense
- It was the first operational packet network
- A global computer network providing a variety of information and communication facilities, consisting of interconnected networks using standardized communication protocols.

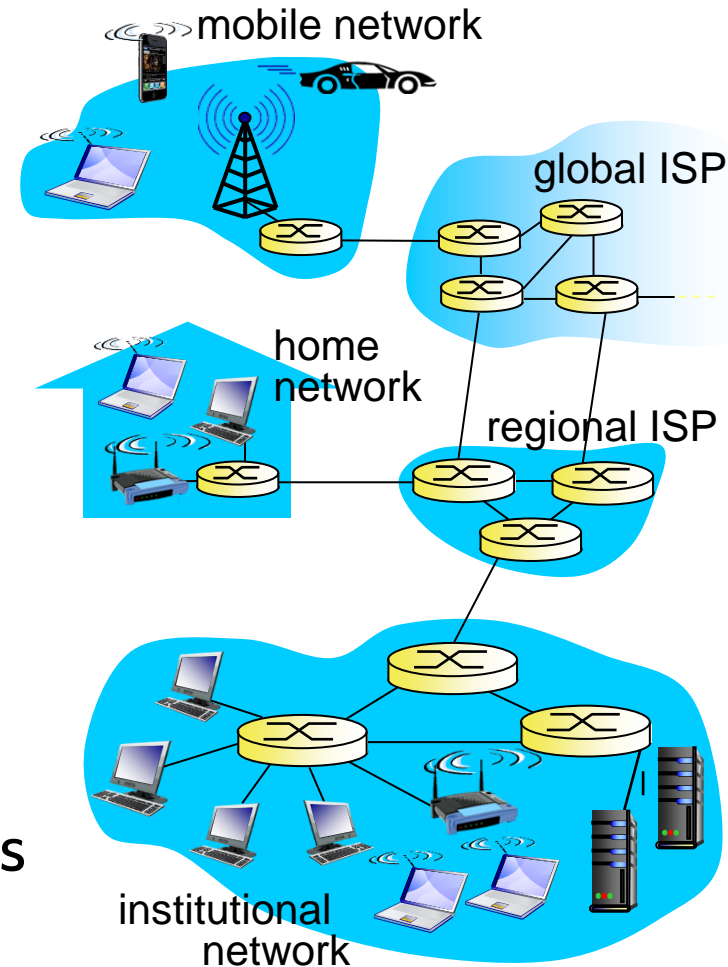
What's the Internet



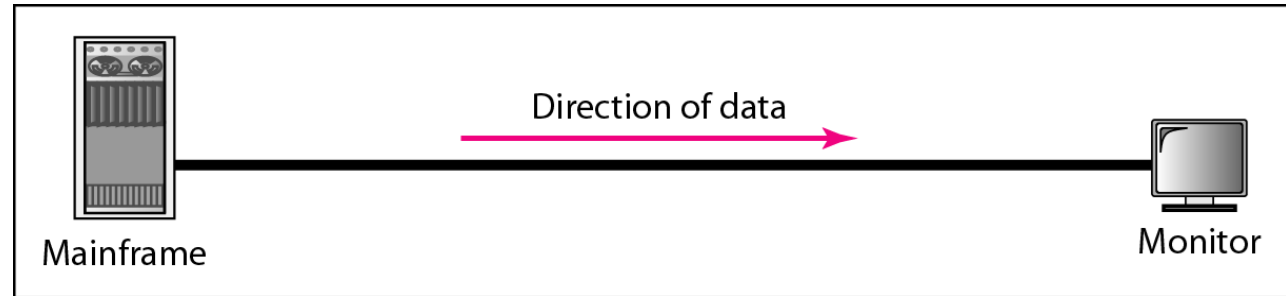
- millions of connected computing devices:
- **network of networks**
 - *hosts* = *end systems*
 - running *network apps*



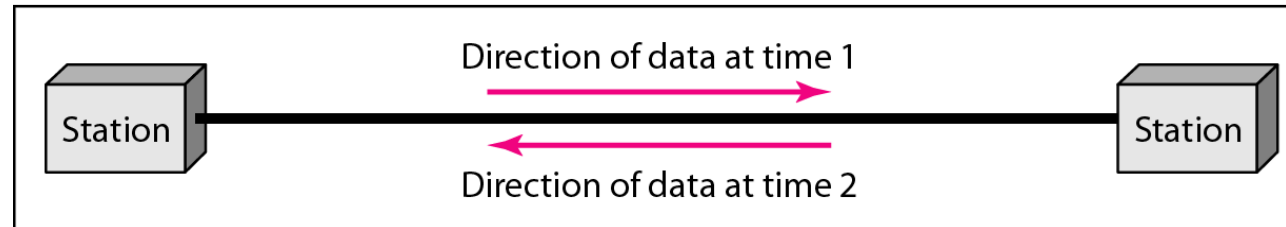
- ❖ **communication links**
 - fiber, copper, radio, satellite
- ❖ forward packets (chunks of data)
 - *routers* and *switches*



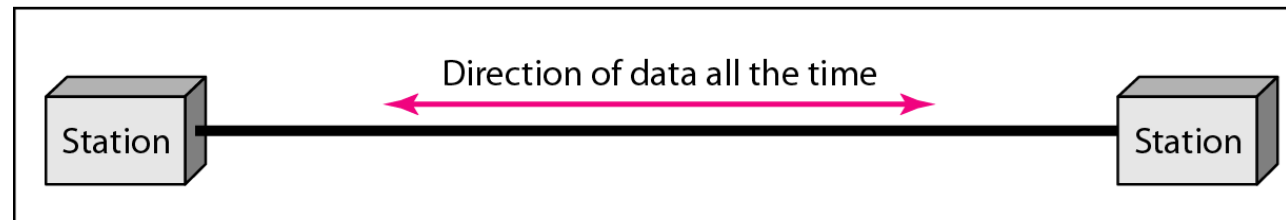
Data flow



a. Simplex

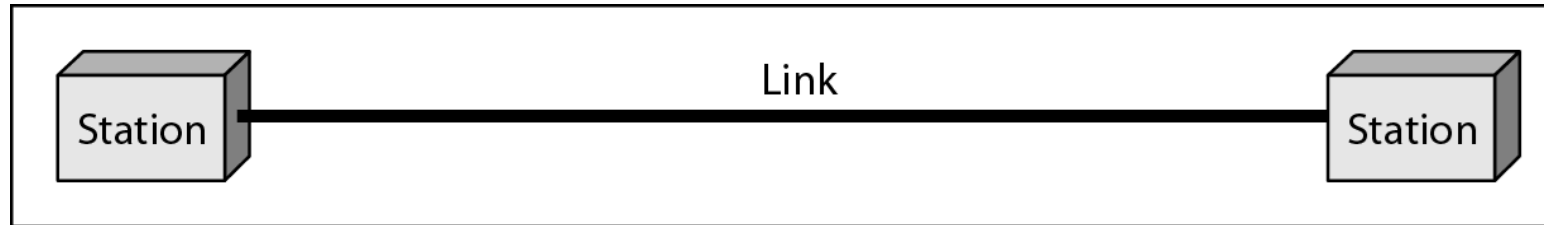


b. Half-duplex

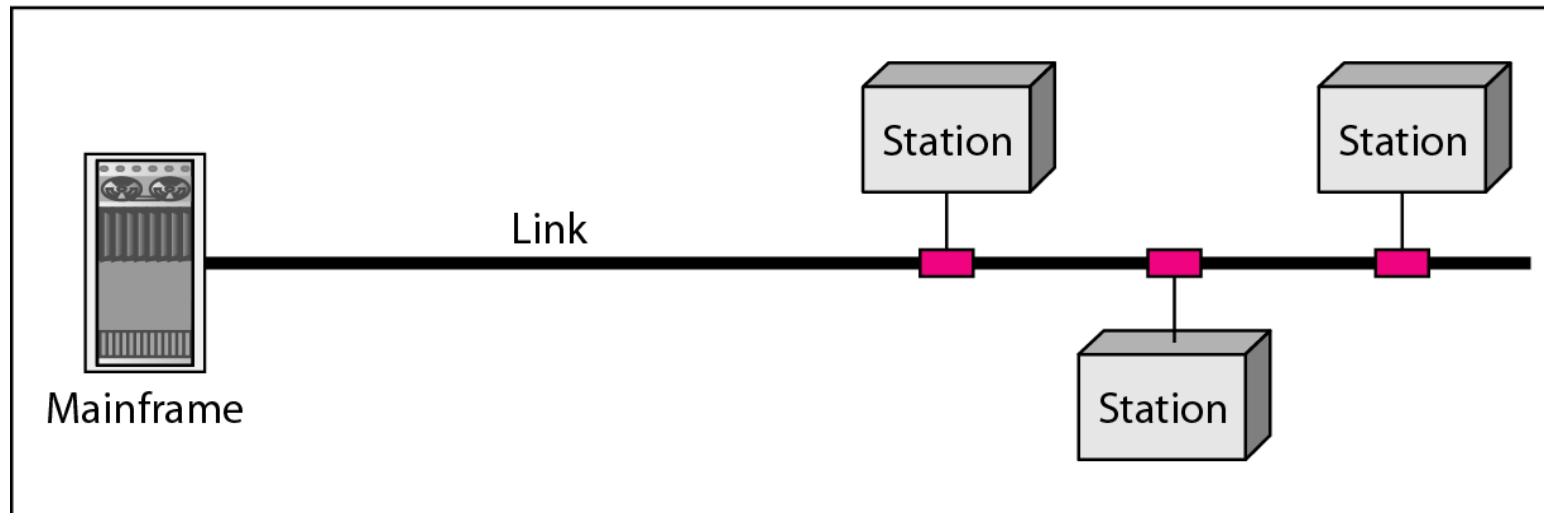


c. Full-duplex

Types of connections



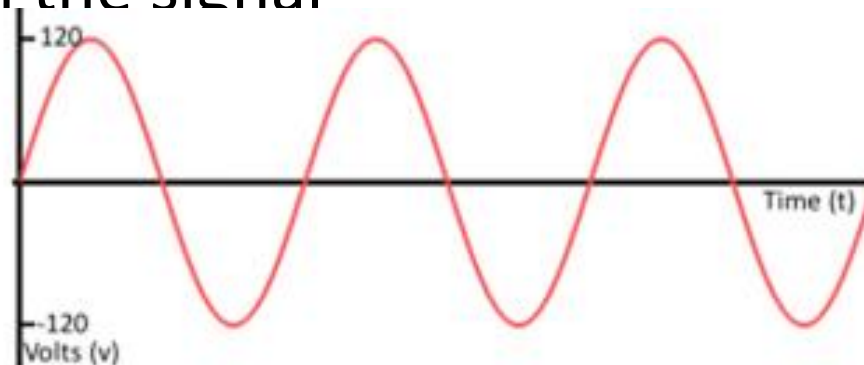
a. Point-to-point



b. Multipoint

Analog Signals

- A continuously varying signal
- Examples of media:
 - Copper wire media , Fiber optic cable
 - Atmosphere or space propagation
- Analog signal - signal intensity varies in a smooth fashion over time
 - No breaks or discontinuities in the signal

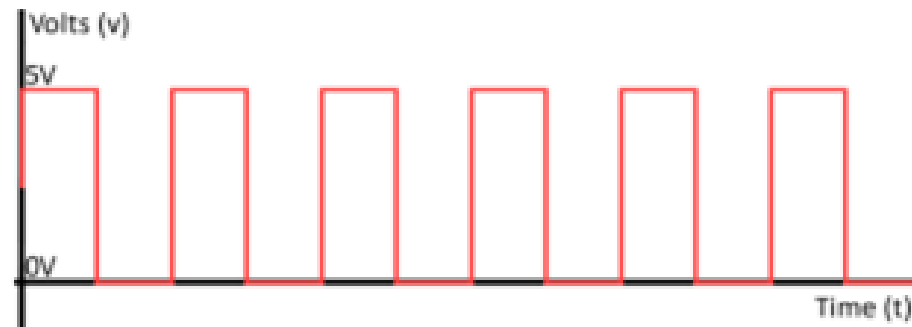


Digital Signals



- A sequence of pulses that may be transmitted over a copper wire medium
- Digital signal - signal intensity maintains a constant level for some period of time and then changes to another constant level

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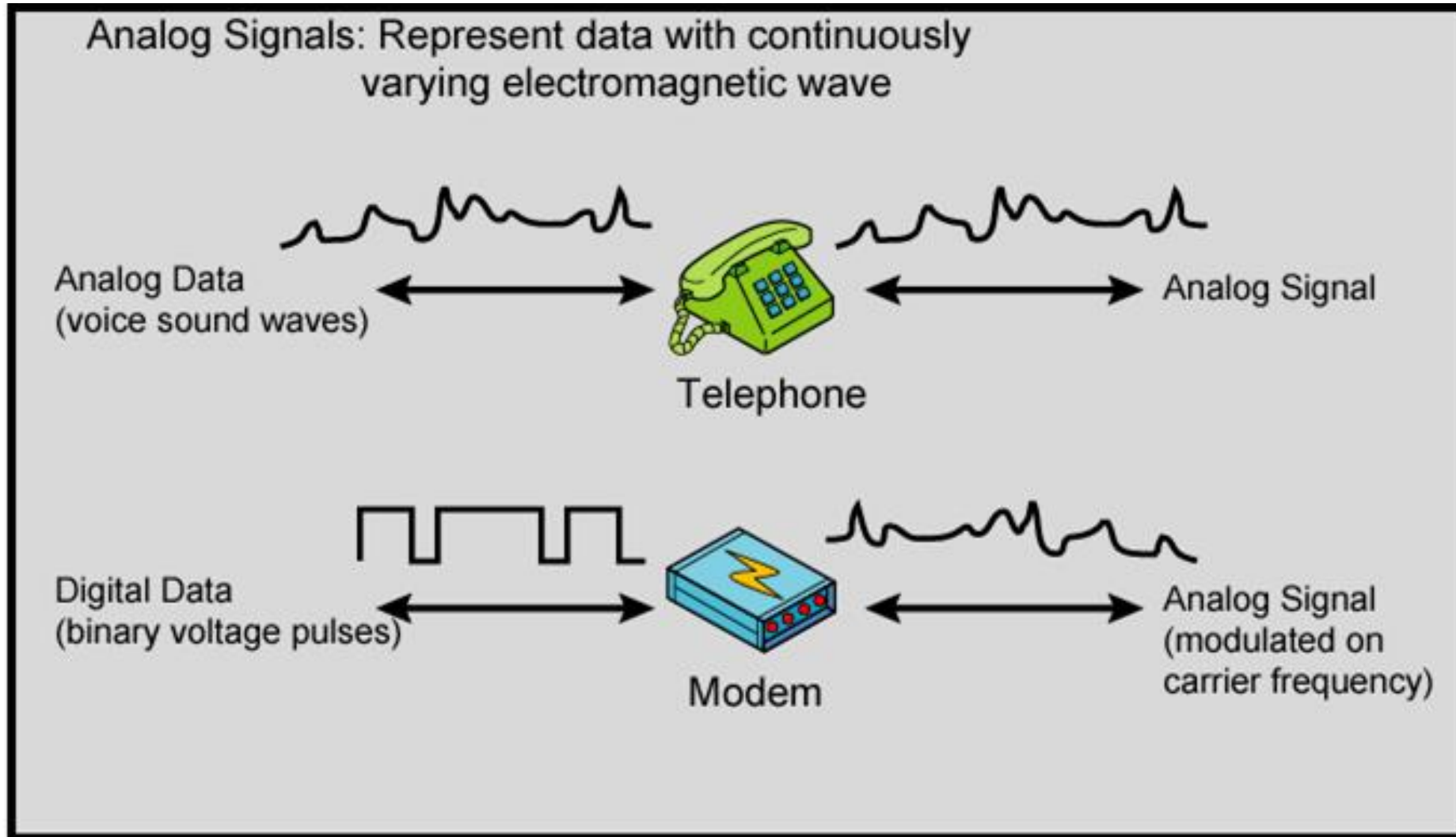


Data and Signals

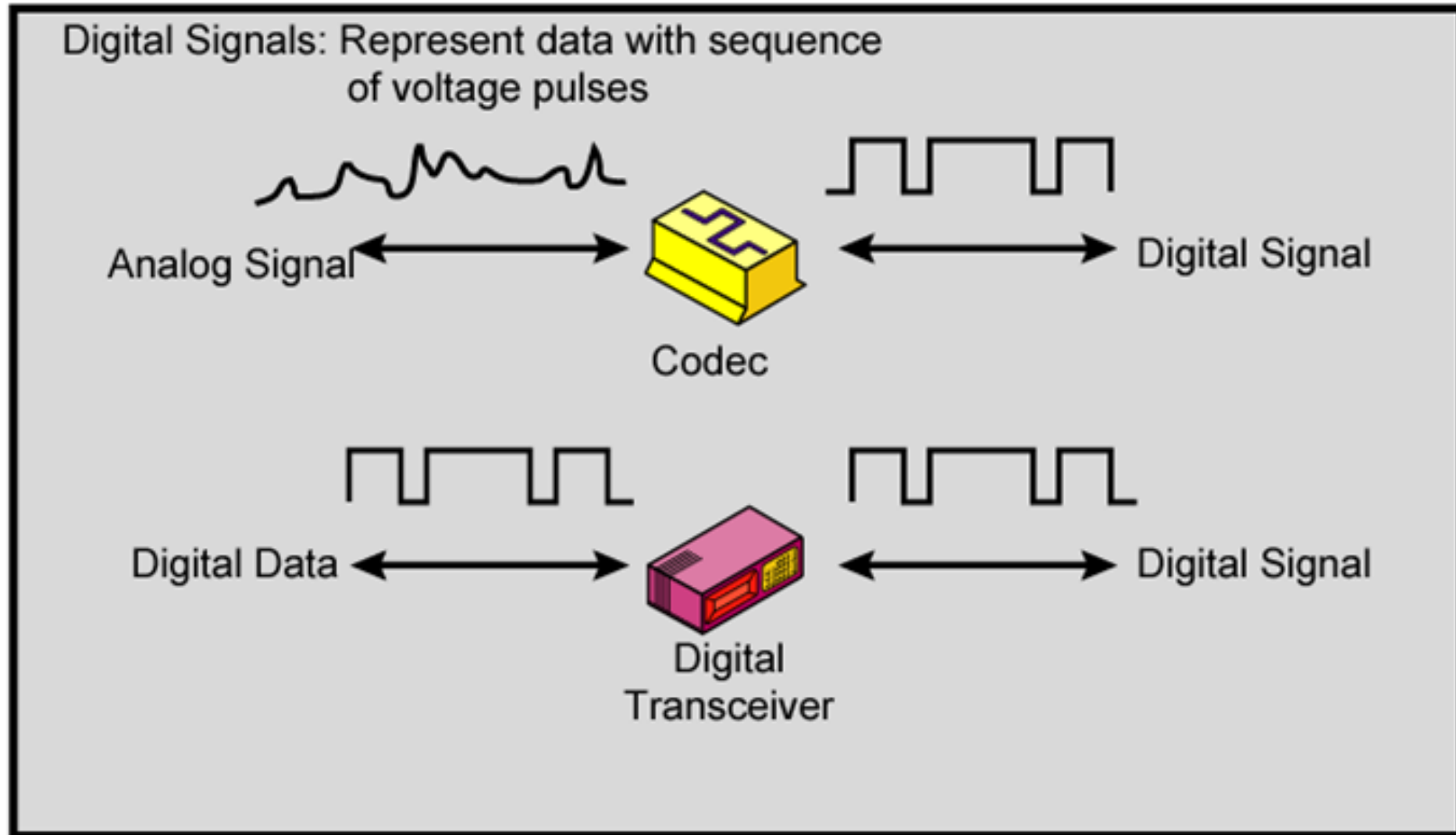


- Usually use digital signals for digital data and analog signals for analog data
- Can use analog signal to carry digital data
 - Modem
- Can use digital signal to carry analog data
 - Compact Disc audio

Analog Signals Carrying Analog and Digital Data



Digital Signals Carrying Analog and Digital Data



Analog Signals Advantages



- Widely Deployed
- Do not require conversion for information that is analog in its native form (requires sampling and special conversion equipment).
- Analog information fully represented in the continuous flow

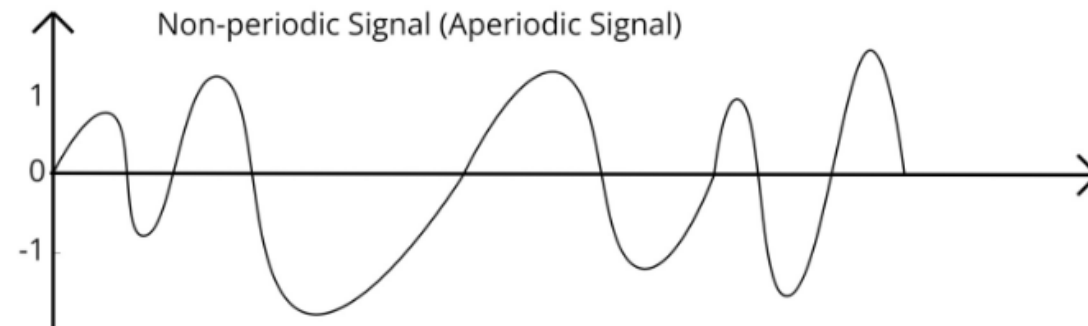
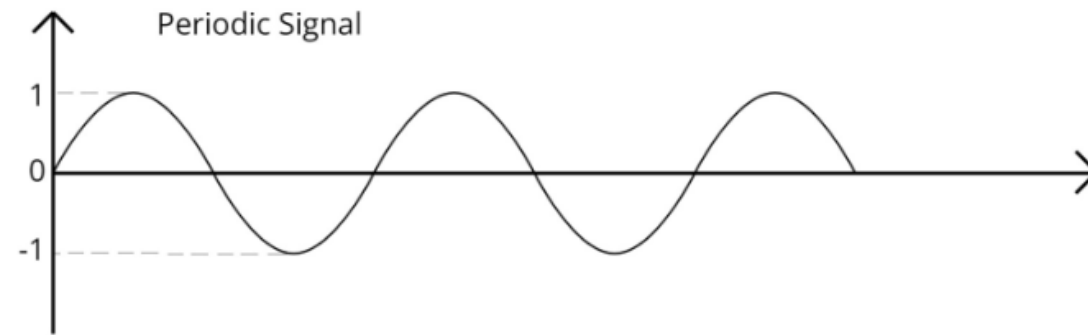
Digital Advantages



- Advantageous for the transmission of digital information.
- **Compression:** Digital data can be compressed effectively and easily.
- **Security:** Security and privacy of the data can be more easily ensured.
- **Error Performance:** Error detection and correction of digital networks is much improved
- **Upgradeability:** digital networks comprise computer components, they can relatively easily be upgraded

Periodic and Non-Periodic Signal

- A periodic signal is a signal that repeats itself at regular intervals of time.
- A non-periodic signal is a signal that does not repeat itself at regular intervals.



Amplitude, Period, Frequency, and Wavelength

- The **period** of a wave is the time it takes to complete one cycle.
- The **frequency** is just the opposite; it's the number of wave cycles that are completed in one second.
- **Amplitude** and wavelength are both measures of distance. The amplitude measures the height of the crest of the wave from the midline.
- The **wavelength** is the distance between adjacent identical parts of a wave.

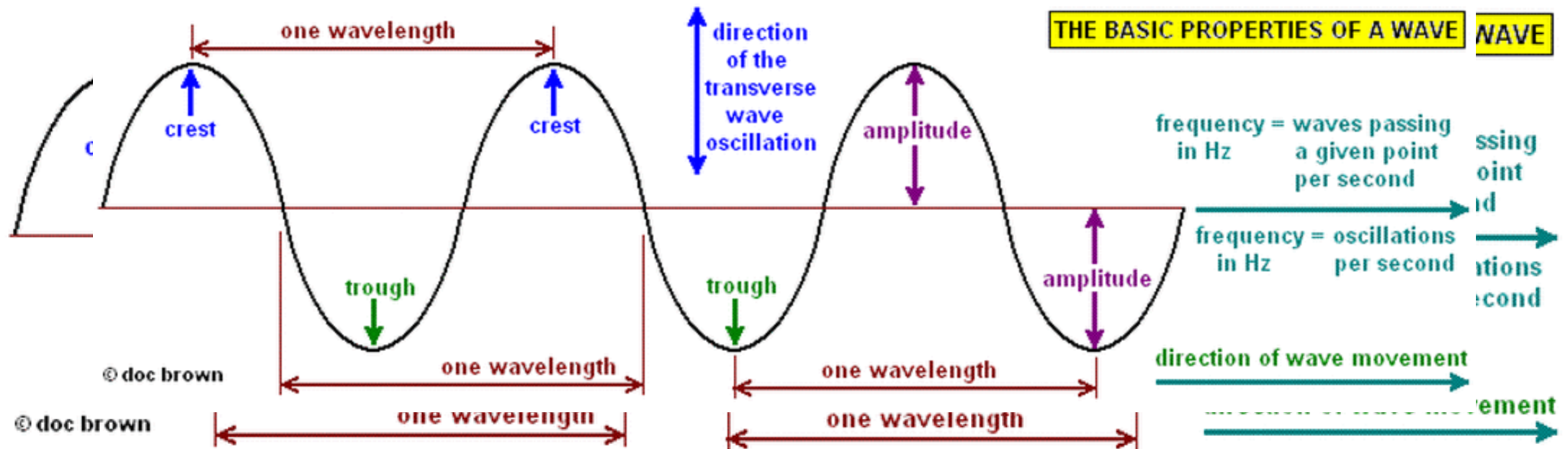
$$f = \frac{1}{T}$$

$$T = \frac{1}{f}$$

$$v_w = \frac{\lambda}{T}$$

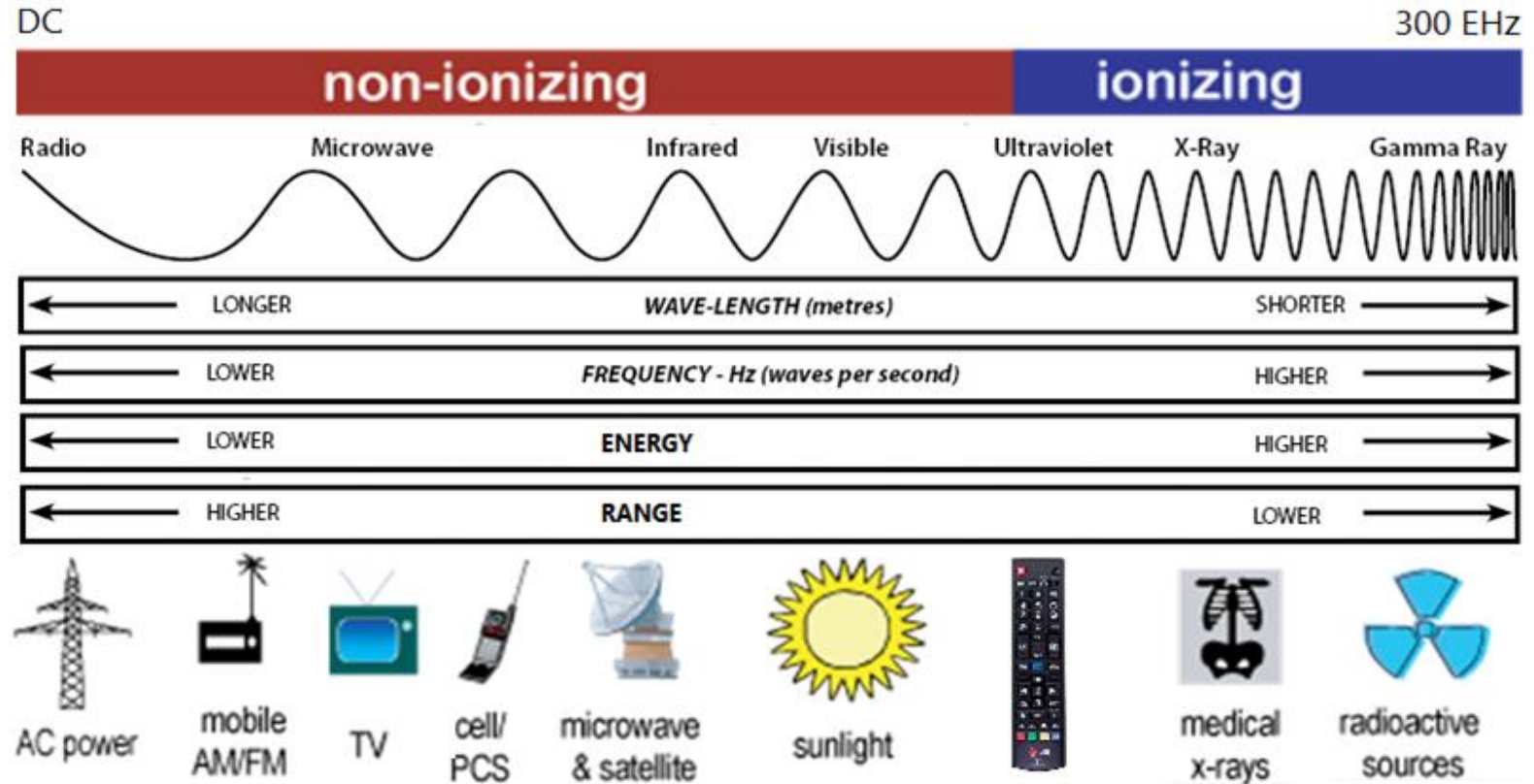
$$v_w = f\lambda.$$

Amplitude, Period, Frequency, and Wavelength



Electromagnetic Spectrum

- Complete range of all known Frequencies is called the electromagnetic spectrum.
- The spectrum is divided into different portion /sub-ranges
- Each portion have different behavior and characteristics



Transmission Impairments



- Signal received may differ from signal transmitted
- Analog - degradation of signal quality
- Digital - bit errors
- Caused by
 - Attenuation and attenuation distortion
 - Delay distortion
 - Noise

Attenuation



- Signal strength falls off with distance
- Depends on medium
- Received signal strength:
 - must be enough to be detected
 - must be sufficiently higher than noise to be received without error
- Attenuation is an increasing function of frequency

Noise (1)



- Additional signals inserted between transmitter and receiver
- Thermal Noise
 - Due to thermal agitation of electrons
 - Uniformly distributed
 - Depends on temperature
- Intermodulation Noise
 - Signals that are the sum and difference of original frequencies sharing a medium

Noise (2)



- Crosstalk
 - A signal from one line is picked up by another
 - unwanted coupling between signals.
 - When signal transmitted on one circuit or channel of a transmission system creates an undesired effect in another circuit or channel
- Impulse Noise
 - Irregular, high amplitude pulses or spikes for short duration
 - Caused by external electromagnetic disturbances, or faults and flaws in the communications system

Channel Capacity



- Data rate
 - In bits per second
 - how much data actually does travel through the 'channel'.
- Bandwidth
 - In cycles per second of Hertz
 - Bandwidth is the maximum amount of data that can travel through a 'channel'.